METHOD FOR CHECKING THE EXISTENCE OF AN OPTICAL DISK USING A FOCUSING SIGNAL

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method for checking the existence of an optical disk, and more specifically, but not by way of limitation, to a method for checking the existence of an optical disk by using the focus error signal or focus OK signal yielded by comparison of a reference level with beam strength signal.

2. Description of the Related Art

FIG. 1 depicts a general optical disk drive system, comprising an optical pickup 2 for reproducing recorded signals from an optical disk 1, a sled motor 9 for moving the optical pickup 2 along the full length of the disk radius, a spindle motor 10 for rotating the optical disk 1, a drive unit 7 for driving the sled motor 9 and the spindle motor 10, an RF unit 3 for equalizing and shaping the RF signal reproduced from the optical disk 1 by the optical

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Assistant Commissioner for Patents
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Sir:

Transmitted herewith for filing is the patent application of

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For: METHOD FOR CHECKING THE EXISTENCE OF AN OPTICAL DISK USING A FOCUSING SIGNAL

Enclosed are:

X A specification consisting of 13 pages

X 07 sheet(s) of Formal drawings

X An assignment of the invention

X Certified copy of Priority Document(s)

X Executed Declaration X Original ___ Photocopy

___ Applicant claims small entity status in accordace with 37 CFR 1.27

___ Application Data Sheet in accordance with 37 C.F.R. 1.76

___ Preliminary Amendment

___ Information Disclosure Statement, PTO-1449 and reference(s)

___ Other _____

___ Applicant requests early publication

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INDEPENDENT	3 - 3 =	0	x80 =$	0.00	or	x 40 = $	0.00
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Respectfully submitted,

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pickup 2, a servo unit 5 for controlling the optical pickup 2 and drive unit 7 using the rotation speed of the optical disk 1 and focus and tracking error signals outputted from the optical pickup 2, a digital signal processing unit 4 for retrieving original digital data from the binary data stream outputted by the RF unit 3, a microcomputer 6 for supervising the operation of the servo unit 5 and digital signal processing unit 4, and a memory 8 for storing data needed for the operation of the microcomputer 6. The focus error (FE) signal generated by the optical pickup 2 will be explained in detail with reference to FIGS. 2A to 2D.

FIG. 2A shows a focus error (FE) signal waveform generated by the optical pickup 2 in the case where no disk is contained in the disk tray of the optical disk drive. Since the incident laser beam is not reflected, the focus error signal is irregular and contaminated by a significant amount of noise, the level of the focus error signal being much lower than a prescribed reference level Ref1a.

FIG. 2B shows a focus error signal waveform generated by the optical pickup 2 when an optical disk has been inserted into the disk tray. In this case, the focus error signal is of a sinusoidal waveform and the level is greater than the reference level Ref1a, the amount of noise being relatively small.

FIG. 2C shows a focus error signal waveform generated by the optical pickup 2 in the case where the disk tray contains an optical disk of a low reflection ratio such as a rewritable optical disk. The general shape of the focus error signal is similar to that in FIG. 2B, but the level of the focus error signal is lower because of the low reflection ratio of the optical disk. Therefore, it is likely that the level of the focus error signal does not exceed the reference level Ref1a and the existence of the

optical disk is not detected. To solve this problem, the reference level should be lowered enough to detect the optical disk with a low reflection ratio.

If a low reference level Ref1b is employed, an optical disk with a low reflection ratio can be detected as long as the level of the focus error signal exceeds the low reference level Ref1b. In this case, however, it is possible that the level of the focus error signal obtained in the case of no disk goes up the reference level Ref1b as shown in FIG. 2D, which leads to a wrong disk detection result.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a method for checking the existence of an optical disk using focus OK signal that prevents misjudgment caused by noise contained in focus error signal.

It is another object of the present invention to provide a method for checking the existence of an optical disk by comparing sum of focus error of which the level is less than a prescribed reference level with another reference level.

The method for checking the existence of an optical disk using focusing signal in accordance with an embodiment of the present invention comprises examining whether a focus OK signal is asserted while moving an optical pickup in the direction of the place where an optical disk is placed, starting detection of the value of focus error if said focus OK signal is asserted, and judging the existence of an optical disk, depending upon the magnitude of detected value.

The method for checking the existence of an optical

disk using focusing signal in accordance with another embodiment of the present invention comprises examining whether the peak of focus error signal exceeds a predefined reference level, while moving an optical pickup in the direction of the place where an optical disk is placed, detecting and summing the magnitude of focusing signal after the peak is detected, and judging the existence of an optical disk, depending upon the magnitude of the sum value.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate the preferred embodiments of the invention, and together with the description, serve to explain the principles of the present invention.

In the drawings:

FIG. 1 is a block diagram for an optical disk drive;

FIGS. 2A to 2D is several focus error signal waveforms measured under various environments;

FIG. 3 is a block diagram of an optical disk drive embodying the present invention;

FIG. 4 is waveforms of important signals used by the method for checking the existence of an optical disk in accordance with an embodiment of the present invention;

FIG. 5 is a flowchart of the method for checking the existence of an optical disk in accordance with an embodiment of the present invention;

FIGS. 6A to 6C are waveforms of focus OK signal and focus error signal obtained when a disk exists and does not;

FIGS. 7A to 7C are waveforms of focus error signal used by the method for checking the existence of an optical

disk in accordance with another embodiment of the present invention; and

FIG. 8 is a flowchart of the method for checking the existence of an optical disk in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In order that the invention may be fully understood, preferred embodiments thereof will now be described with reference to the accompanying drawings.

FIG. 3 shows an optical disk drive embodying the present invention, comprising an optical pickup 2 for reproducing recorded signals from an optical disk 1, a sled motor 9 for moving the optical pickup 2 along the full length of the disk radius, a spindle motor 10 for rotating the optical disk 1, a drive unit 7 for driving the sled motor 9 and the spindle motor 10, an RF unit 3 for equalizing and shaping the RF signal reproduced from the optical disk 1 by the optical pickup 2 and for creating a focus OK (FOK) signal, a servo unit 5 for controlling the optical pickup 2 and drive unit 7 using the rotation speed of the optical disk 1 and focusing and tracking error signals outputted from the optical pickup 2, a digital signal processing unit 4 for retrieving original digital data from the binary data stream outputted by the RF unit 3, an A/D converter 11 for digitizing the focus error signal from the optical pickup 2, a microcomputer 6 for supervising the operation of the servo unit 5 and digital signal processing unit 4 and for checking the existence of an optical disk using the digitized focus error signal and the focus OK (FOK) signal, and a memory 8 for storing data needed for the operation of the microcomputer 6.

FIG. 4 shows the waveforms of four important signals used by an embodiment of the present invention for checking the existence of an optical disk. The first signal is the focus drive signal corresponding to the focus control signal (FCS) created by the servo unit 5. The second signal is the beam strength signal (BS) outputted by the optical pickup 2 while the objective lens moves in response to the focus drive signal. In a 3-beam optical pickup, the sub-beam-added signal is generally used as the beam strength signal. In a 1-beam optical pickup, however, the beam strength signal is derived from the filtered RF signal. The third signal is the focus OK (FOK) signal created by comparison the beam strength (BS) signal and a predefined reference signal C1 set low enough to detect the existence of a rewritable optical disk. The last signal is the focus error signal. The method for checking the existence of an optical disk using these signals will be explained in detail with reference to the block diagram in FIG. 3 and a flowchart shown in FIG. 5.

When the disk tray closes or at power-on of the optical disk drive (S1), the microcomputer 6 initializes a sum variable (S2) and starts focus search. In response to the focus search command, the servo unit 5 outputs the focus control signal to move the objective lens. The RF unit 3 generates the focus OK (FOK) signal by comparing the beam strength (BS) signal with a predefined reference level C1.

The microcomputer 6 examines the state of the focus OK (FOK) signal (S3) and starts A/D conversion of the focus error signal if the focus OK signal is asserted (S4). Therefore, A/D conversion of the focus error signal is performed only while the level of the focus OK signal is high, as shown in FIG. 6A. Then, the microcomputer 6 adds

the digitized focus error to the sum variable only if the digitized error exceeds a predetermined reference level C_{MIN} (S5).

Finally, the microcomputer 6 compares the sum value with a predetermined level set for disk detection (S6) and concludes that an optical exists if the sum value is greater than the predetermined level (S7).

Even when an optical disk does not exist, the focus error signal may exceed the reference level C_{MIN} because of noise as shown in FIG. 6B. In this case, however, the focus OK (FOK) signal is not asserted and therefore the focus error signal is not digitized, which makes the sum variable remain unchanged. Consequently, the microcomputer 6 concludes no disk to exist (S8) and misjudgment due to noise is prevented.

The focus OK signal might be asserted by a burst noise as shown in FIG. 6C. In this case, however, the duration of the high state of the focus OK signal is relatively short compared to that created in a normal situation. Since the focus error signal is sampled only during the short interval, the sum of the sampled focus error is likely to be lower than the predefined level. In addition, even if the duration of the asserted focus OK signal is long, the sum of the sampled focus error is not likely to exceed the level because the focus error signal is generated only by noise.

As a result, the existence of an optical disk can be checked with no misjudgment by sum of the digitized focus error sampled only while the focus OK signal is asserted, despite the existence of noise.

FIGS. 7A to 7C show focus error signal waveforms used by another embodiment of the present invention. FIG. 7A shows a typical waveform of normal focus error signal

obtained when an optical disk exists in the disk tray. It is seen that the peak level of the focus error is greater than a high reference level C_{UMIN} as well as than a low reference level C_{LMIN}.

FIG. 7B shows an example waveform of the focus error signal generated by a rewritable optical disk. Owing to the low reflection ratio of the rewritable optical disk, the peak level of the focus error is greater than the low reference level C_{LMIN} but less than the high reference level C_{UMIN}.

FIG. 7C shows an example waveform of the focus error signal obtained when no disk is contained in the disk tray. It is seen that the focus error signal is irregular and seriously contaminated by noise and the peak value may exceed the low reference level C_{LMIN}, without exceeding the high reference level C_{UMIN}.

For correct detection of the existence of an optical disk, therefore, the difference of the two waveforms shown in FIGS. 7B and 7C should be discerned. Such discrimination can be achieved by using the focus error signal lower than the low reference level C_{LMIN}. The sampled focus error of which the level is lower than the low reference level C_{LMIN} is added and compared with a predefined reference level since the signal below the low reference level C_{LMIN} is insensitive to a noise. Table 1 gives the added absolute values obtained by experiments in each case.

【Table 1】

	Rewritable disk		No disk	
	Above zero (+)	Below zero (-)	Above zero (+)	Below zero (-)
1	898Eh	6122h	5FA7h	0000h
2	8B23h	530Fh	86BFh	0000h

3	6B70h	66C7h	8D08h	0000h
4	7232h	63D3h	7420h	0000h
5	7790h	63B4h	88A0h	0000h
6	908Eh	5CBAh	7D09h	0000h
7	66e6h	6302h	72F2h	0000h
8	870Dh	6666h	7D27h	0000h
9	8D0Bh	561Ch	6F1Eh	0000h
10	8495h	5A8Ah	7156h	0000h

h = hexadecimal

It is shown that in the case of an optical disc with a low reflection ratio, the sum of the absolute values of focus error less than the low reference level C_{LMIN} is much greater than 0, whereas in the case of no disk, the sum value is near 0. This fact implies that the two cases can be clearly discriminated if an appropriate reference level between the two sum values is chosen. The method in accordance with another embodiment of the present invention is explained in detail with reference to FIG. 8.

When the disk tray closes or at power-on of the optical disk drive (S10), the objective lens moves upward to find focus point (S11). The microcomputer 6 digitizes the focus error signal at a constant rate, detects the peak point, and compares the peak level with a high reference level C_{UMIN} (S12). Only when the peak level is greater than the high reference level C_{UMIN}, the microcomputer 6 samples the focus error signal for a given time duration (S13) after the peak is detected. And the microcomputer 6 adds the absolute values of the sampled focus error of which the level is lower than a low reference level C_{LMIN} (S14) and then compares the sum value with a predefined value (S15). If the sum value is less than the predefined value, the

microcomputer 6 concludes that a disk does not exist (S17). Otherwise, it concluds that a disk has been inserted (S16).

It is possible to add the absolute values, which are above noise level, separately according to the sign of the focus error and to make a decision by comparing the smaller value with the reference level.

The method for checking the existence of an optical disk in accordance with the present invention prevents misjudgment of the existence of an optical disk which are caused by noise contained in focus error signal or low reflection ratio of a disk.

The invention may be embodied in other specific forms without departing from the sprit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A method for checking the existence of an optical disk using a focusing signal, comprising the steps of:

(a) checking whether a focus OK signal is asserted while moving an optical pickup in the direction of the place where an optical disk is placed;

(b) starting detection of the value of focus error if said focus OK signal is asserted; and

(c) judging the existence of an optical disk, depending upon the magnitude of detected value.

2. The method set forth in claim 1, wherein in said step (b) said value of focus error is obtained by sampling

said focus error signal at constant intervals and summing the sampled values.

3. The method set forth in claim 2, wherein in said step (b) said summing is carried out on sampled focus error greater than a predefined reference level.

4. The method set forth in claim 1, wherein an optical disk is judged to exist if the magnitude of the detected value is greater than a predefined reference level.

5. A method for checking the existence of an optical disk using focusing signal, comprising the steps of:

(a) examining whether the peak of focus error signal exceeds a predefined reference level, while moving an optical pickup in the direction of the place where an optical disk is placed;

(b) detecting the magnitude of focusing signal of which the sign is opposite to the peak, if confirmed in said step (a); and

(c) judging the existence of an optical disk, depending upon the magnitude of detected value.

6. The method set forth in claim 5, wherein in said step (b) the detection of the magnitude is carried out by sampling said focus error signal at constant intervals after the peak is detected and summing the sampled values.

7. The method set forth in claim 6, wherein in said step (b) the absolute value of detected level is summed only if the detected level is less than a predefined reference level.

8. The method set forth in claim 5, wherein an optical disk is judged to exist if the magnitude of said detected value is greater than a predefined reference level.

9. A method for checking the existence of an optical disk using focusing signal, comprising:

detecting the magnitude of focus error signal of

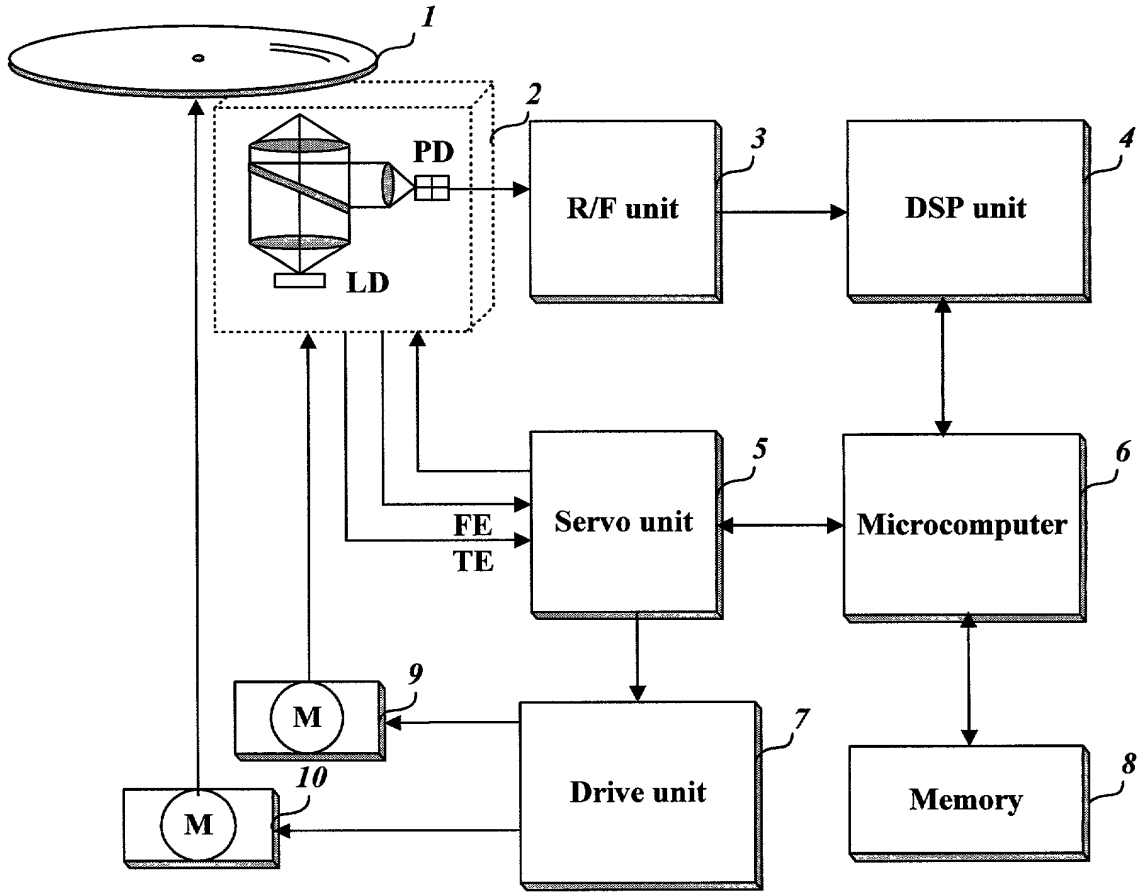
which the level is less than a predefined reference level; and

judging the existence of an optical disk, depending upon the magnitude of detected value.

ABSTRACT OF DISCLOSURE

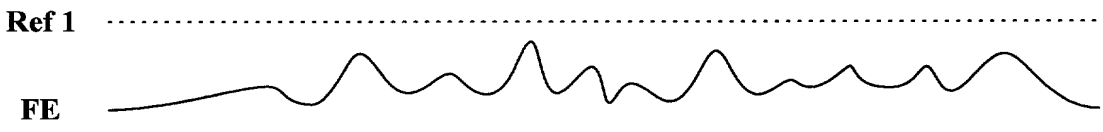
A method for checking the existence of an optical disk using focusing signal is provided. The method in accordance with the present invention prevents misjudgment of the existence of an optical disk which are caused by noise contained in focus error signal or low reflection ratio of a disk.

FIG. 1



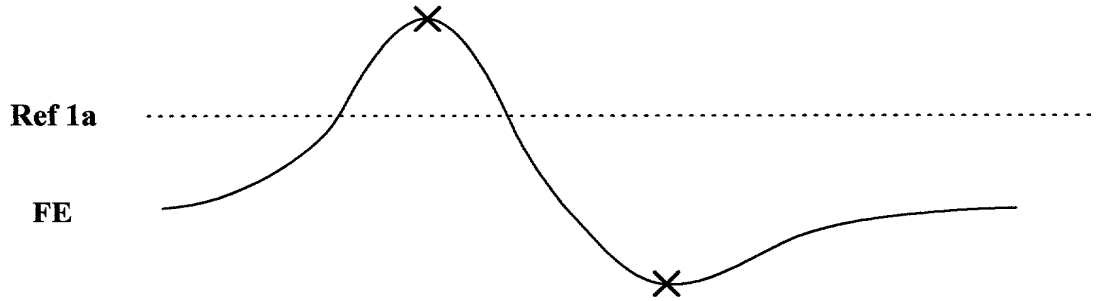
Conventional Art

FIG. 2A



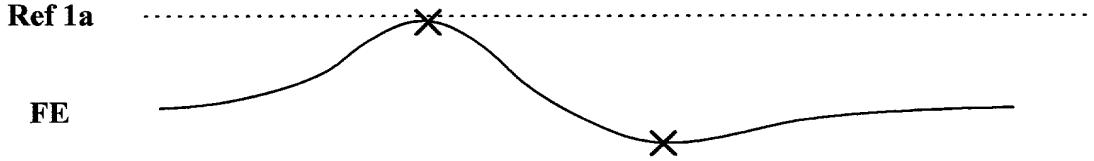
Conventional Art

FIG. 2B



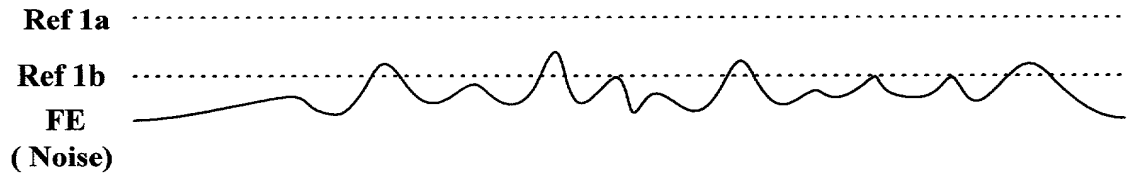
Conventional Art

FIG. 2C



Conventional Art

FIG. 2D



Conventional Art

FIG. 3

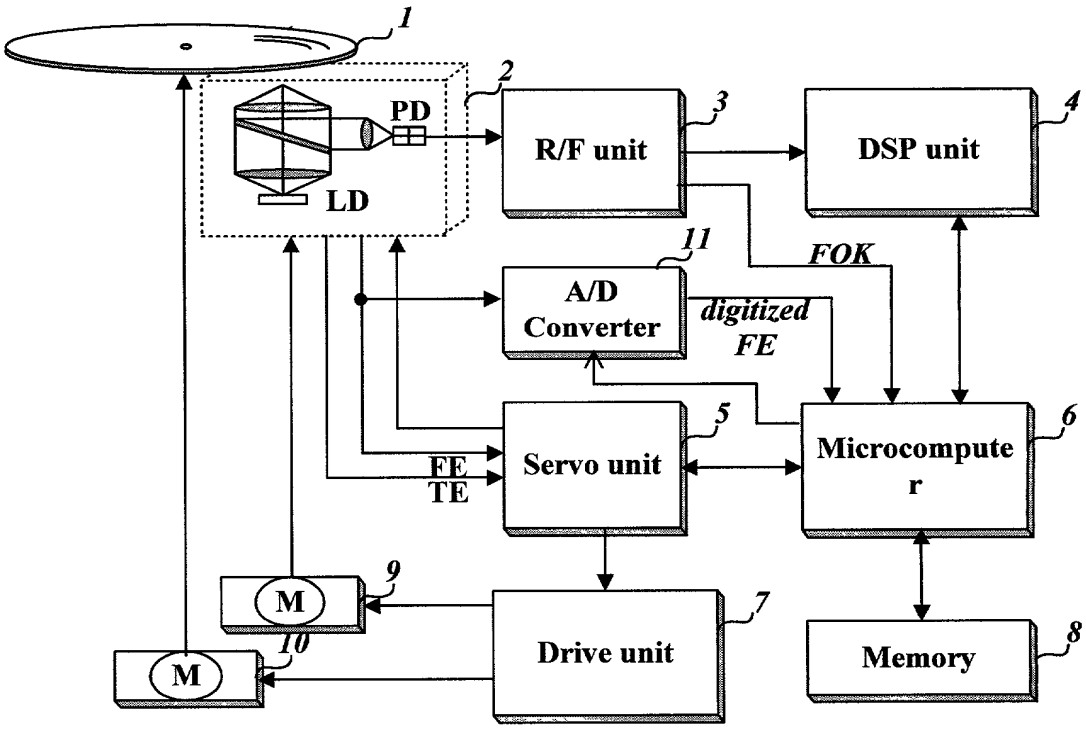

1
2
PD
LD
R/F unit
3
DSP unit
4
11
A/D
Converter
FOK
digitized
FE
5
Servo unit
6
Microcompute
r
FE
TE
9
M
7
Drive unit
10
M
Memory
8

FIG. 4

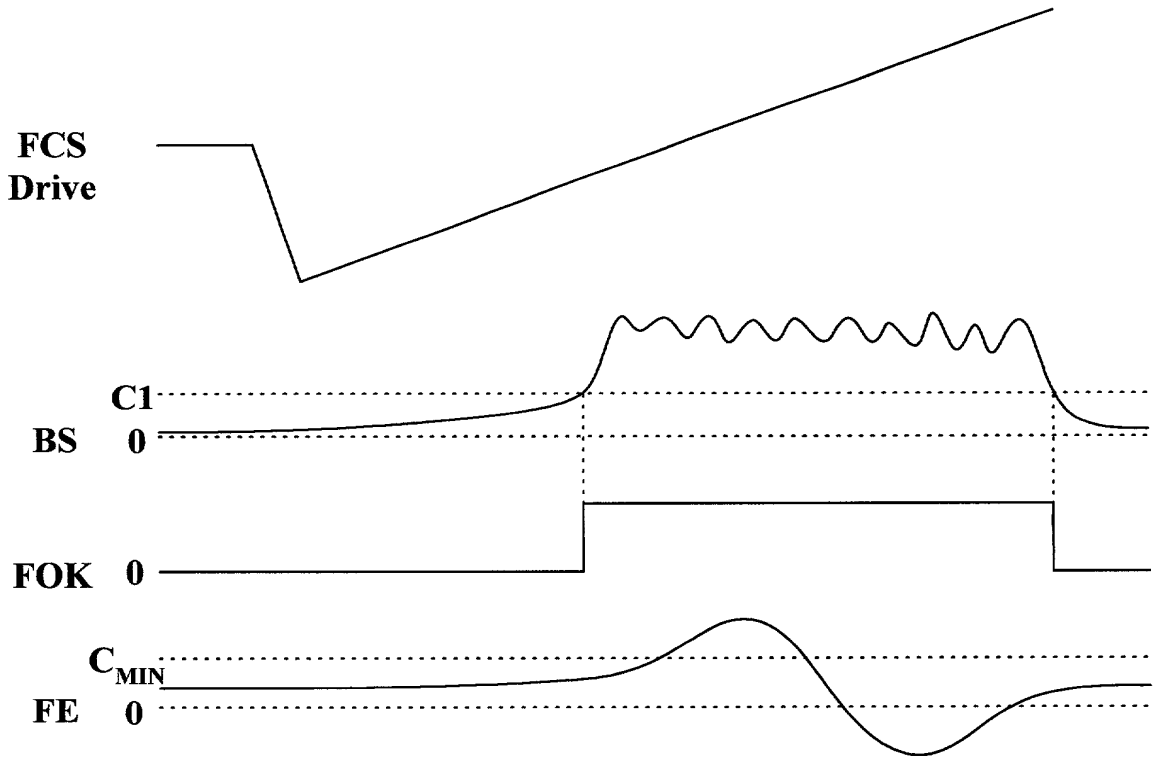

FCS
Drive
C1
BS 0
FOK 0
C_MIN
FE 0

FIG. 5

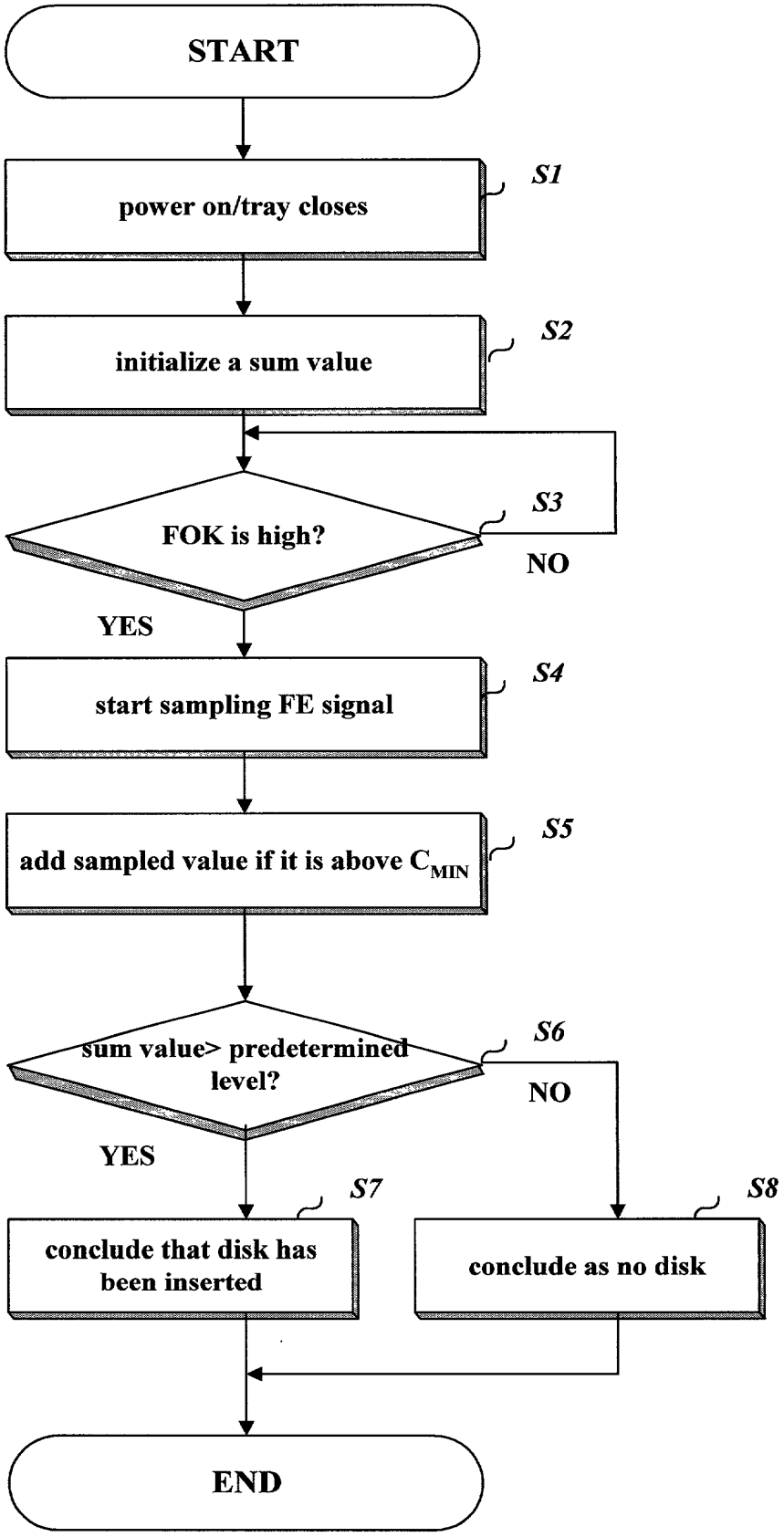

START
power on/tray closes
S1
initialize a sum value
S2
FOK is high?
S3
NO
YES
start sampling FE signal
S4
add sampled value if it is above C_{MIN}
S5
sum value> predetermined level?
S6
NO
YES
conclude that disk has been inserted
S7
conclude as no disk
S8
END

FIG. 6A

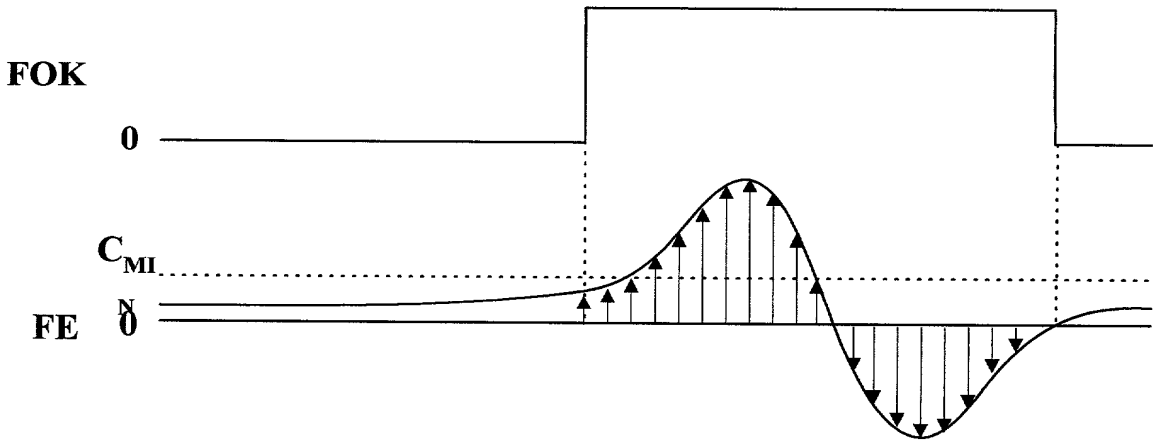


FIG. 6B

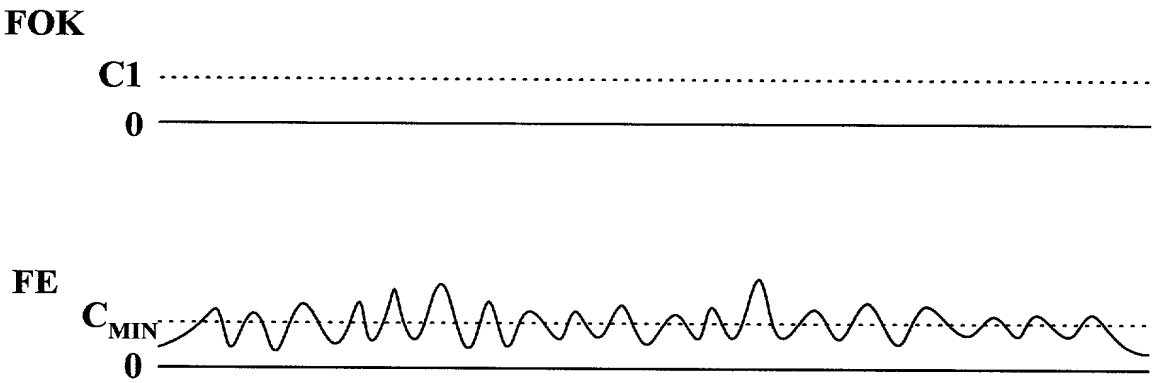


FIG. 6C

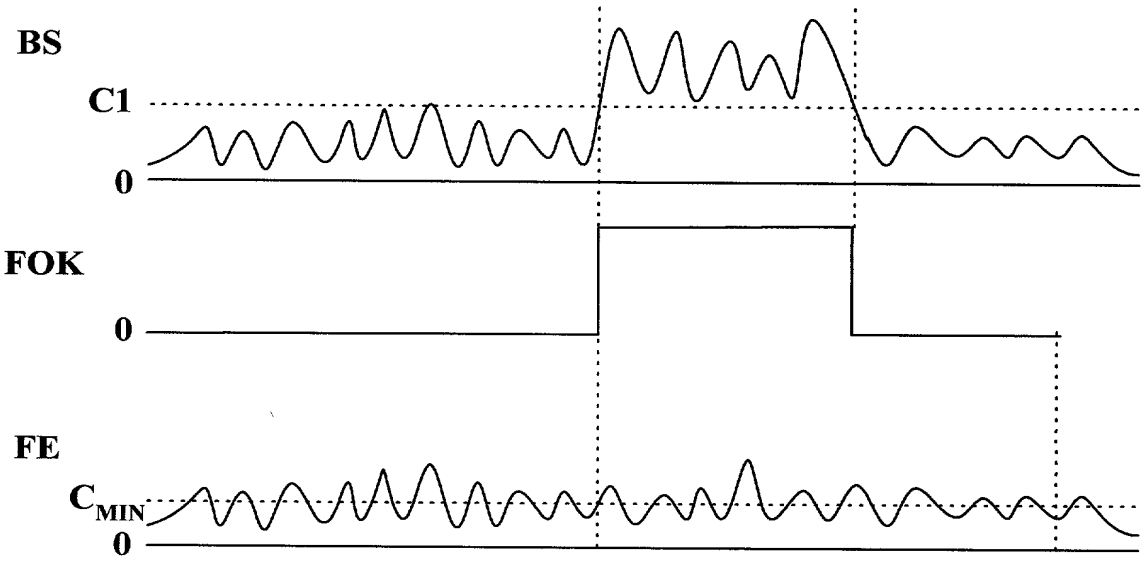


FIG. 7A

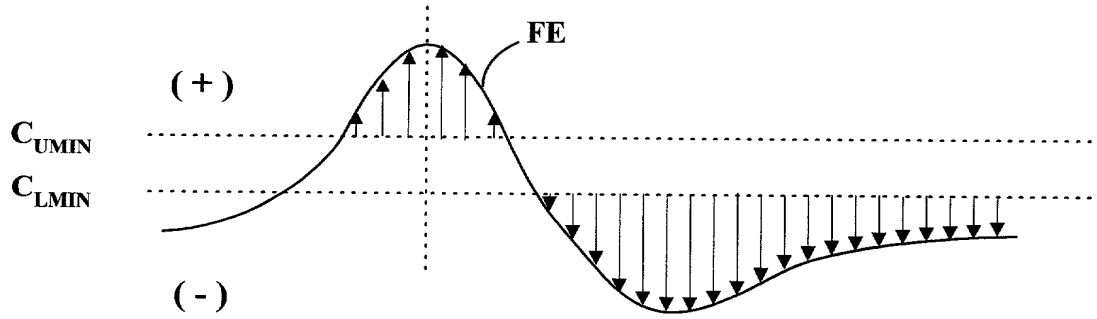


FIG. 7B

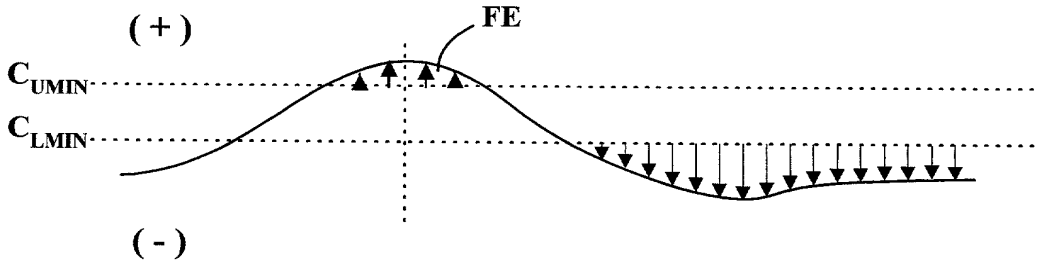


FIG. 7C

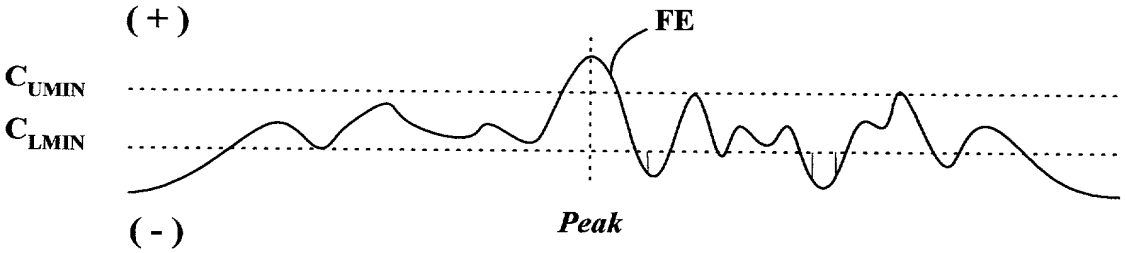
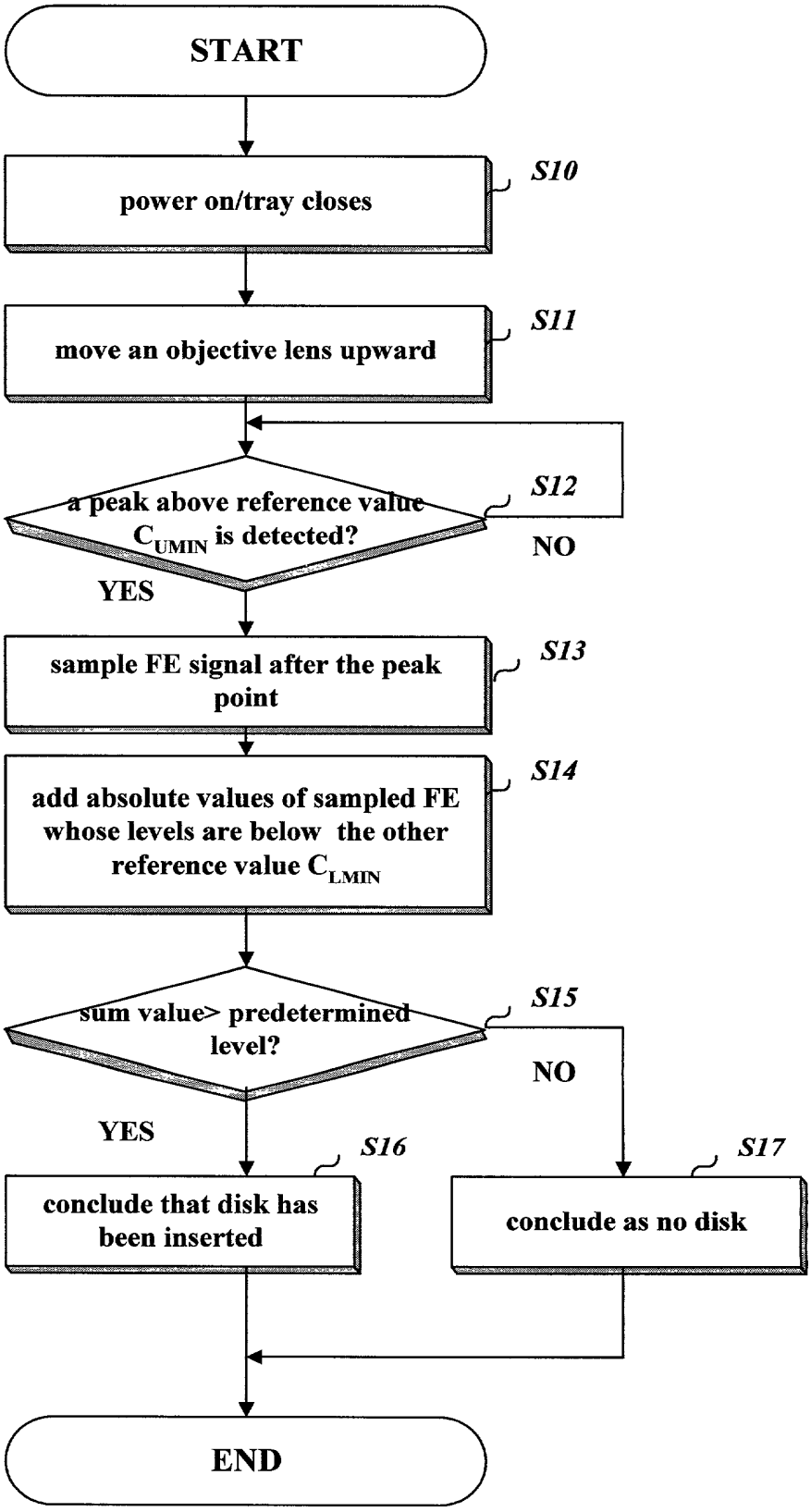


FIG. 8


START
power on/tray closes
S10
move an objective lens upward
S11
a peak above reference value C_{UMIN} is detected?
S12
NO
YES
sample FE signal after the peak point
S13
add absolute values of sampled FE whose levels are below the other reference value C_{LMIN}
S14
sum value> predetermined level?
S15
NO
YES
S16
conclude that disk has been inserted
S17
conclude as no disk
END

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PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT AND DESIGN APPLICATIONS

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Insert Title: METHOD FOR CHECKING THE EXISTENCE OF AN OPTICAL DISK USING A FOCUSING SIGNAL

Fill in Appropriate Information - For Use Without Specification Attached:

the specification of which is attached hereto. If not attached hereto,
the specification was filed on _____ as
United States Application Number _____;
and amended on _____ (if applicable) and/or
the specification was filed on _____ as PCT
International Application Number _____; and was
amended under PCT Article 19 on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, .56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representative or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, 19(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Insert Priority Information: (if appropriate)

Prior Foreign Application(s)			Priority Claimed	
99-56727 (Number)	Korea (Country)	12/10/99 (Month/Day/Year Filed)	☒ Yes	☐ No
99-56728 (Number)	Korea (Country)	12/10/99 (Month/Day/Year Filed)	☒ Yes	☐ No
(Number)	(Country)	(Month/Day/Year Filed)	☐ Yes	☐ No
(Number)	(Country)	(Month/Day/Year Filed)	☐ Yes	☐ No

I hereby claim the benefit under Title 35, United States Code, 19(e) of any United States provisional applications(s) listed below.

Insert Provisional Application(s): (if any)

(Application Number)	(Filing Date)
(Application Number)	(Filing Date)

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More than 12 Months (6 Months for Designs) Prior to the Filing Date of This Application:

Insert Requested Information: (if appropriate)

Country	Application Number	Date of Filing (Month/Day/Year)

I hereby claim the benefit under Title 35, United States Code, 20 of any United States and/or PCT application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States and/or PCT application in the manner provided by the first paragraph of Title 35, United States Code, 12, I acknowledge the duty to disclose information which is material to the patentability as defined in Title 37, Code of Federal Regulations, .56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

Insert Prior U.S. Application(s): (if any)

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

2950-0176P
Attorney Docket No.

I hereby appoint the following attorneys to prosecute this application and/or an international application based on this application and to transact all business in the Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

Raymond C. Stewart	(Reg. No. 21,066)	Terrell C. Birch	(Reg. No. 19,382)
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Send Correspondence to:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of First or Sole Inventor Insert Name of Inventor → Insert Date This Document is Signed

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Full Name of Fifth Inventor, if any: see above

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*DATE OF SIGNATURE